

## **Complete Listing of the Claims**



1 Claim 1. (cancelled) A method to determine the best fit parameters of a broadening model to be  
2 used to correct for the effects of band broadening in a chromatographic separation containing a  
3 separation device followed by two or more detectors comprising the steps of

- 4 a) Selecting a broadening model containing a set of adjustable parameters;
- 5 b) Injecting a sample containing a monodisperse component;
- 6 c) Collecting the signals from each of said detectors corresponding to said monodisperse  
7 component;
- 8 d) Forming a  $\chi^2$  model to be minimized over the peak of said monodisperse component  
9 using said collected signal of the most broadened detector signal as a reference against  
10 which the said other detector signals are to be broadened;
- 11 e) Minimizing the  $\chi^2$  model to determine said best fit parameters for each of said detector  
12 signals to be broadened so that their broadened and normalized shapes are a best fit to  
13 said shape of said detector producing said broadest temporal response.

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15 Claim 2. (cancelled) The method of Claim 1 where the minimization of said  $\chi^2$  model is  
16 achieved by use of a nonlinear least squares algorithm.

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18 Claim 3. (cancelled) The method of Claim 2 where said nonlinear least squares algorithm is of  
19 the type developed by Marquart.

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21 Claim 4. (cancelled) The method of Claim 1 where said  $\chi^2$  model to be minimized is

22 
$$\chi^2_i(\beta_i, \tau_i, \alpha_{ij}) = \int_{peak} \left( D_n(t) - \beta_i \int_{-\infty}^{\infty} D_i(t-\tau) B(\alpha_{ij}, \tau - \tau_i) d\tau \right)^2 dt$$
, where said best fit parameters

1 are the  $\beta_i, \alpha_{ij}$ , and  $\tau_i$ ; the  $i$ -detectors' responses as a function of time are the  $D_i(t)$ ; and said model  
2 is minimized over said peak.

3  
4 Claim 5. (cancelled) The method of Claim 1 where said band broadening is caused by dilution.

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6 Claim 6. (cancelled) The method of Claim 1 where said broadening is caused by mixing.

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8 Claim 7. (cancelled) The method of Claim 6 where said mixing arises from inclusions caused by  
9 mechanical defects within the detector cells and/or connectors therefore.

10  
11 Claim 8. (cancelled) The method of Claim 1 where said broadening is caused by internal  
12 instrumental effects.

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14 Claim 9. (cancelled) The method of Claim 8 where said internal instrumental effects are caused  
15 by electronic filtering.

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17 Claim 10. (cancelled) The method of Claim 8 where said internal instrumental effects are caused  
18 by differences of the sample volume measured by each detector.

19  
20 Claim 11. (withdrawn) A method to derive selected physical properties of a sample passing  
21 successively through a set of detectors using a combination of the signals produced by said  
22 detectors responding to said sample passing therethrough when some of said detectors exhibit  
23 band broadening of their signals, comprising the steps of

- 1 a) Applying a parameterized broadening function to said detector set to derive thereby a  
2 corresponding set of detector signals, all of which have comparable broadening; and  
3 b) Using said detector signals now broadened, following application of said broadening  
4 function, to derive said selected physical properties of said measured sample.  
5

6 **Claim 12.** (withdrawn) The method of Claim 11 where said application of said parameterized  
7 broadening function is given by  $D_i^b(t) = \int_{-\infty}^{\infty} D_i(t-\tau) B(\alpha'_{ij}, \tau - \tau'_i) d\tau$  where  $D_i^b(t)$  are the said  
8 detector signals now broadened,  $\alpha'_{ij}$  and  $\tau'_i$  are said best fit parameters of Claim 2.  
9

10 **Claim 13.** (withdrawn) The method of Claim 11 where said selected physical properties, to be  
11 determined from the relation  $R(\theta) = K^* M_w c P(\theta) [1 - 2A_2 M_w c P(\theta)] + O(c^3)$ , are the weight  
12 averaged molar mass,  $M_w$ , and the root mean square radius,  $r_g$ , of said sample derived from  
13 concentration signals,  $c(t)$ , and the excess Rayleigh ratios,  $R(\theta, t)$ , derived from  $i$  light scattering  
14 signals from a detector set comprised of light scattering detectors,  $D_i(t)$ , and a dRI detector in  
15 sequence, said dRI detector producing a concentration signal exhibiting broadening relative to  
16 said light scattering detector signals, where said light scattering detector signals have been  
17 broadened.  
18

19 **Claim 14.** (withdrawn) The method of Claim 11 where said detector signals are from a UV  
20 detector followed by a multiangle light scattering detector and said multiangle light scattering  
21 signals are broadened.  
22

1 Claim 15. (withdrawn) The method of Claim 11 where said detector signals are from a refractive  
2 index detector followed by a viscometer detector and said refractive index detector signals are  
3 broadened.

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5 Claim 16. (withdrawn) The method of 11 where said broadening function is given by

6 
$$B(t) = \int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\tau^2/2\sigma^2} \frac{1}{w} U(t-\tau) e^{-(t-\tau)/w} d\tau, \text{ where } U(t-\tau) = 1 \text{ when } t \geq \tau \text{ and } = 0 \text{ when } t < \tau.$$

7  
8 Claim 17. (withdrawn) The method of Claim 16 where said optimal parameters of said  
9 broadening function have been determined by the method of Claim 1.

10  
11 Claim 18. (cancelled) A method to determine the delay volumes,  $\tau_i, i = 1 \text{ to } N-1$ , between  $N$   
12 detectors in a chromatographic separation system using the method of Claim 2.

13  
14 Claim 19. (new) A method to determine the best fit parameters of a broadening model to be used  
15 to correct for the effects of interdetector band broadening in a chromatographic separation  
16 containing a separation device followed by two or more detectors comprising the steps of

- 17 A. Selecting a broadening model containing a set of adjustable parameters;  
18 B. Injecting a reference sample;  
19 C. Collecting the signals in time corresponding to a peak of uniform composition from each  
20 of said detectors of said sample, where a peak is defined as a range of time during which  
21 the sample of uniform composition elutes;  
22 D. defining the most broadened peak as that corresponding to the peak having the broadest  
23 temporal response.

1 E. Forming a  $\chi^2$  model to be minimized over a peak of said sample to be broadened using  
2 said collected signal of the most broadened peak as a reference against which the said  
3 other detector peaks are to be compared;

4 
$$\chi^2_i(\beta_i, \tau_i, \alpha_{ij}) = \int_{peak} \left( D_n(t) - \beta_i \int_{-\infty}^{\infty} D_i(t-\tau) B(\alpha_{ij}, \tau - \tau_i) d\tau \right)^2 dt, \text{ where}$$

5 (1) said best fit parameters are the  $\beta_i, \alpha_{ij}$ , and  $\tau_i$ ; and

6 (a) the  $\beta_i$  are scale factors;

7 (b) the  $\alpha_{ij}$  characterize the extent of the broadening, and

8 (c) the  $\tau_i$  are the interdetector time delays.

9 (2) the  $i$ -detectors' responses as a function of time are the  $D_i(t)$  and said model is  
10 minimized over said peak.

11 F. Minimizing said  $\chi^2$  model to determine said best fit parameters for each of said detector  
12 peaks to be broadened so that their broadened and normalized shapes are a best fit to said  
13 shape of said detector producing said broadest temporal response.

14  
15 Claim 20. (new) The method of Claim 19 where the minimization of said model is achieved by  
16 use of a nonlinear least squares algorithm.

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18 Claim 21. (new) The method of Claim 20 where said nonlinear least squares algorithm is of the  
19 type developed by Marquardt.

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21 Claim 22. (new) The method of Claim 19 where said band broadening is caused by dilution.

1 Claim 23. (new) The method of Claim 19 where said band broadening is caused by mixing.

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3 Claim 24. (new) The method of Claim 19 where said band broadening is caused by mechanical  
4 defects within the detector cells and/or connectors thereto.

5  
6 Claim 25. (new) The method of Claim 19 where said band broadening is caused by internal  
7 instrumental averaging.

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9 Claim 26. (new) The method of Claim 25 where said internal instrumental averaging is from  
10 electronic filtering.

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12 Claim 27. (new) The method of Claim 25 where said internal instrumental averaging is by  
13 measuring a range of volumes of the sample.

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15 Claim 28. (new) The method of Claim 19 where said peaks of uniform composition correspond  
16 to monodisperse fractions which are separated from the other fractions by said chromatographic  
17 separation.

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19 Claim 29. (new) The method of Claim 19 where said peaks of uniform composition correspond  
20 respectively to fractions for which said chromatographic separation device produces no  
21 appreciable separation so that said sample elutes with a uniform composition.

1 Claim 30. (new) The method of Claim 19 where said broadening model is given by

2 
$$B(\alpha_1, \alpha_2, t) = \int_{-\infty}^{\infty} \frac{1}{\alpha_1 \sqrt{2\pi}} e^{-\tau^2/2\alpha_1^2} \frac{1}{\alpha_2} U(t-\tau) e^{-(t-\tau)/\alpha_2} d\tau, \text{ where } U(t-\tau) = 1 \text{ when } t \geq \tau \text{ and}$$

3 
$$U(t-\tau) = 0 \text{ and } t < \tau.$$